



*GEO THERMAL
RESOURCE
TECHNOLOGIES, INC.*

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FORMATION THERMAL CONDUCTIVITY TEST AND DATA ANALYSIS

for

**Tennessee Valley Authority
P.O. Box 1010, CSC 1A
Muscle Shoals, Alabama 35662-1010
(256) 386-2713 • Fax: (256) 386-3529**

Test location

**Brick Hatton School
Leighton, Alabama**

June 5, 2000

Test Performed by

Geothermal Resource Technologies, Incorporated

Executive Summary

A formation thermal conductivity test was performed by Geothermal Resource Technologies, Inc., on a test bore located near Brick Hatton School in Leighton, Alabama. The Formation Thermal Conductivity testing unit was attached to the vertical u-bend assembly on the evening of Thursday, June 1, 2000. The collected data was analyzed by Geothermal Resource Technologies, Inc. under the supervision of Charles Remund, Ph.D., Director of Engineering.

This report provides a general overview of the test and procedures that were used to perform the thermal conductivity test along with a plot of the data in a form used to calculate the formation thermal conductivity. The following average formation thermal conductivity was found from the data analysis.

⇒ Formation Thermal Conductivity = 1.358 Btu/hr-ft-°F

Test Procedure

The procedure for the formation thermal conductivity test is as follows:

1. Connect the u-bend ground heat exchanger pipe to the portable FTC unit.
2. Connect the data acquisition unit to the wiring harness in the FTC unit.
3. Connect the FTC unit to 240 volt power supply (collected data indicated the average voltage throughout the tests was 240.3 volts).
4. Fill and purge air from the FTC unit.
5. Insulate the exposed u-bend pipes (leading from the well bore surface to the FTC unit).
6. Simultaneously turn on the heating elements and initiate the data acquisition device.
7. Routinely monitor that the power supply remains connected and the water level of the fluid reservoir within the FTC unit stays at an acceptable level.
8. After the test is completed, turn off heating elements, the circulation pump, and the data acquisition device.

Data Analysis

Geothermal Resource Technologies, Inc. uses the "line source" method of data analysis. The line source equation used is not valid for early test times. Also, the line source method assumes an infinitely thin line source of heat in a continuous medium. If a u-bend grouted in a borehole is used to inject heat into the ground at a constant rate in order to determine the average formation thermal conductivity, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant.

In order to analyze real data from a formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger is plotted versus the natural log of time. Using the Method of Least Squares, the linear equation coefficients are then calculated that produce a line that fits the data. This procedure is normally repeated for various time intervals to ensure that variations in the power or other effects are not producing erroneous results.

Formation Thermal Conductivity Test Report

Date June 1 - 3, 2000
Location Leighton, AL

Borehole Data

Undisturbed Soil Temperature Approximately 63°F
Borehole Depth 300 ft.
Borehole Diameter 6 in.
Drill Log

0 - 65'	Dense Clay
65' - 94'	Gravel/Clay w/ some water
94' - 230'	Limestone
230' - 250'	Black Shale w/ Nat. Gas
250' - 300'	Limestone

U-bend Size 1 in. HDPE, Driscopipe
U-Bend Length 410'
Grout Type No Grout - Cuttings
Grouted Portion Entire Bore Length
Grout Solids Not Applicable

Test Data

Average Power 4,438 W
Calculated Circulator Flow Rate 5.91 gpm
Total Heat Input Rate 13,976 Btu/hr

Line Source Data Analysis

Brick Hatton School, Leighton, AL

June 1 - 3, 2000

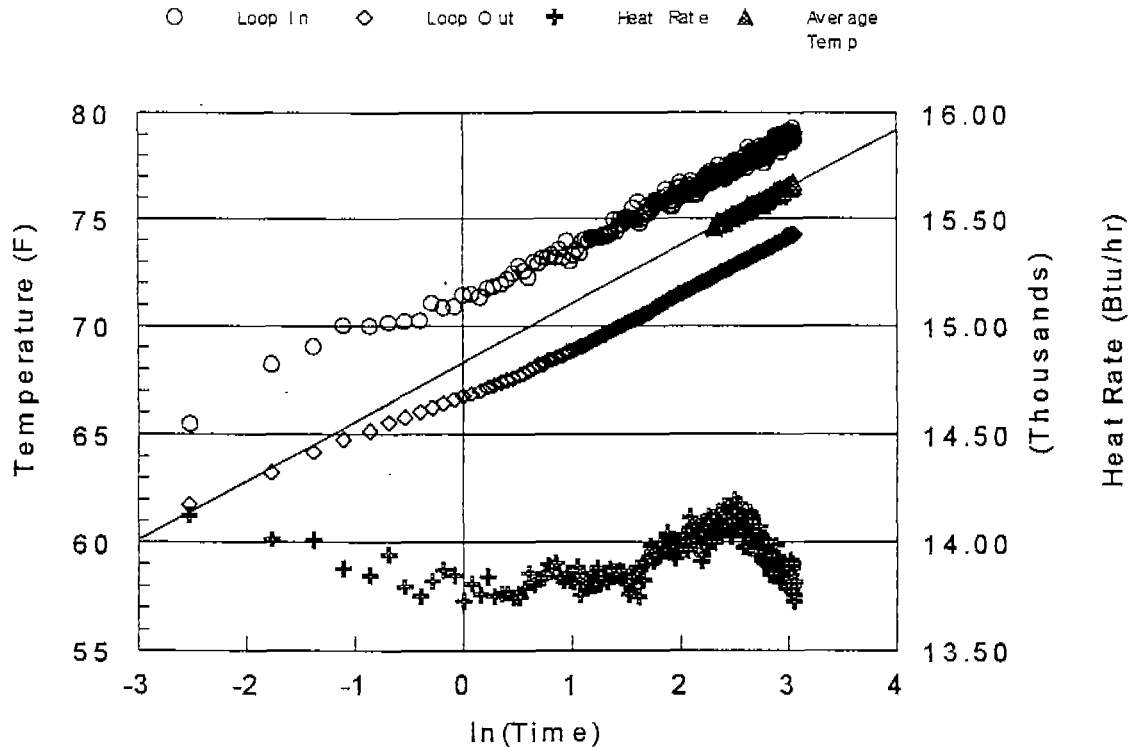


Figure 1: Temperature versus Natural Log of Time

Slope: a_1	Average Heat Input (Btu/hr-ft)	Thermal Conductivity (Btu/hr-ft-°F)
2.730	46.59	1.358

The temperature versus time data was analyzed using the line source analysis for the time period shown above. The slope of the curve (a_1) was found to be 2.730. The resulting thermal conductivity was found to be 1.358 Btu/hr-ft-°F.

Formation Thermal Conductivity Test Well Installation Form

Date of Well Completion: MAY 31, 2000

Drilling Contractor:

Driller: Mike Martin
Company: Miller Drilling Co.
Address: P.O. Box 706
City, State, Zip: Lawrenceville, GA
Phone: 931-762-7548 Fax: 931-762-6381

Bore Information:

Completed Depth: 300 ft.

Bore Diameter: 6 1/8 in.

Deep Earth Temperature: ? F

Drilling Log:

Type of Material

Start/Finish Depth

TOP SOIL

0-1

CLAY

1-60

CLAY, Gravel

60-94

Light Gray limestone

94-160

Med. Gray limestone

160-220

Black shell

220-250

Light gray shell

250-300

Location of test bore:

side Brick Hutton
unbol. @ North Side
beside play ground

Well
MAKING
GAS

U-bend Assembly information:

Nominal Diameter: _____ in.

Actual Assembly Length: 2-200 ft.

Installed Length (depth): 300 ft.

U-bend Assembled by: ☒ Pipe Manufacturer ☐ Drilling Contractor ☐ Other

Pipe Manufacture: Drisco

Grout Information:

Grout Manufacturer: _____

Product (e. g. BH 20): _____

Percent Solids as Mixed: _____

Grouted Depth: _____ ft.

Other Backfill Material if NOT:
Grouted for the Entire Depth: Spoils

I hereby certify that the above information is accurate to the best of my knowledge.

Drillers Signature

Date

MAY 31, 2000